Results of an Intervention to Improve Lead Safety Among Painting Contractors and Their Employees

Barbara L. Materna, PhD, CIH,[1]* David Harrington, MPH,[1] Peter Scholz, MPH, CIH,[1] Susan F. Payne, MA,[1] Harrison A. Stubbs, PhD,[2] Karen Hipkins, MPH, NP-C,[2] Emily Merideth, MPH,[2] Luz Kirsch, BA,[2] Geoffrey Lomax, MPH,[2] Patricia Coyle, MPH,[1] and Connie Uratsu, BS[2]

Background *Residential and commercial painters disturb lead paint on older buildings, exposing workers and potentially building occupants. An intervention strategy was evaluated for improving lead safety in these small businesses.*
Methods *Twenty-one painting contractors received 32 hr of training, technical assistance, and a safety manual; their employees attended an 8-hr training session. Impact evaluation involved interviewing participants at baseline, immediately post-intervention, and 1 year later, and conducting contractor focus groups post-intervention.*
Results *Employers met 15 of 27 target objectives and workers met 3 of 12; however, even in areas where objectives were not met, both groups made improvements.*
Conclusions *Motivated contractors and their employees can make moderate improvements in lead-safe practices if provided with extensive training and technical assistance. Changes that are costly, unfamiliar, or perceived as a threat to work quality are more difficult to implement.* Am. J. Ind. Med. 41:119–130, 2002. *Published 2002 Wiley-Liss, Inc.*[†]

KEY WORDS: lead poisoning; occupational health; lead paint; evaluation; intervention; painters; small business

INTRODUCTION

Residential and commercial painters are at risk of lead poisoning because their work tasks frequently generate lead paint dust and fume. Although the US Consumer Product Safety Commission prohibited the addition of lead to paint for use in homes or public buildings in 1978, older buildings usually contain one or more layers of lead-containing paint. Common methods to prepare surfaces for repainting can produce large amounts of fine lead dust or fume. Numerous studies have shown that airborne lead levels exceeding 50 ug/m^3 are generated by power sanding, dry manual sanding and scraping, and heat gun use [NIOSH, 1992; OSHA, 1993; Washington State Department of Labor and Industries, 1995; EPA, 1997; NIOSH, 1997; Sussell et al., 1998, 1999; NIOSH, 2001; Reames et al., 2001; Scholz et al., 2002].

Surface preparation work by painters puts workers at risk and can also contaminate the building and surrounding property if not done properly. There are both case reports and population studies documenting elevated blood lead levels (BLLs) in children which is attributable to renovation and remodeling work [Rabinowitz et al., 1985; Amitai et al., 1987; Marino et al., 1990; Amitai et al., 1991; EPA, 1999; Franko et al., 1997]. Paint removal using common methods has been shown to cause significant amounts of lead to scatter and settle over a widespread area, and cleanup was found to be often inadequate for reducing contamination to safe levels [EPA, 1997; Sussell et al., 1999; NIOSH, 2001].

In addition, lead dust brought home by painters on their clothes, shoes, or bodies may endanger household

[1]Occupational Lead Poisoning Prevention Program (OLPPP), Occupational Health Branch, California Department of Health Services, Oakland, California
[2]Public Health Institute, Berkeley, California
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*Correspondence to: Barbara L. Materna, Occupational Lead Poisoning Prevention Program (OLPPP), Occupational Health Branch, California Department of Health Services, 1515 Clay Street, Suite 1901, Oakland, CA 94612. E-mail: bmaterna@dhs.ca.gov

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members, especially young children. Studies have documented higher BLLs among children of construction workers as compared to neighborhood controls, as well as lead contamination in the automobiles and homes of construction workers [Piacitelli et al., 1997; Whelan et al., 1997].

National statistics indicate that the painting trade consists largely of small businesses, with the average painting contractor employing approximately five workers [Bureau of the Census, 1990]. There is often little safety awareness among small business owners, including knowledge of applicable OSHA regulations; they also lack resources for health and safety personnel.

In 1992, Congress passed the Residential Lead-Based Paint Hazard Reduction Act, commonly referred to as ''Title X,'' prompting national attention, scientific research, and regulatory action aimed at the public health problems associated with lead paint in housing and construction work that disturbs lead paint (Residential Lead-Based Paint Hazard Reduction Act, 1992). Title X required the Federal Occupational Safety and Health Administration (OSHA) to issue an interim final rule regulating occupational exposure to lead in construction (29 CFR 1926.62) which became effective in June 1993 (OSHA, 1993). As a result of these events in the early 1990s, painters' exposure to lead became an issue of concern to painting industry trade associations (e.g., Painting and Decorating Contractors of America) and the International Union of Painters and Allied Trades; this interest supported the development of the project described here.

The California Department of Health Services' Occupational Lead Poisoning Prevention Program (CDHS/OLPPP) conducted a 2-year intervention research project (called the California Painters Project) to address the lead poisoning risks associated with painters' surface preparation work. The goal was to evaluate whether a comprehensive intervention strategy of education, training, and technical assistance would be effective in encouraging residential and commercial painting contractors to establish lead safety programs and comply with the new OSHA standard. We also expected to generate information on the feasibility and efficacy of this strategy in order to make recommendations for replication by others, including state and local health departments.

A final purpose of the project was to assess painters' lead exposure through personal air monitoring, BLLs and zinc protoporphyrin (ZPP) testing. These results, which generally support other studies documenting high airborne lead levels associated with surface preparation tasks but low to moderate BLLs among painters, appear elsewhere [Scholz et al., 2002; CDHS, 1998]. Because painters' exposures to lead are highly variable and intermittent and given that we could not quantify individuals' recent lead exposure prior to a BLL test, we knew it would be impossible to distinguish changes in BLLs due to the intervention.

Although this project focused on one particular industry, we anticipated that the experience gained would be broadly applicable to other attempts by public health practitioners to improve health and safety conditions in industries where small businesses predominate. Other researchers have reviewed the literature on occupational health and safety interventions, highlighting the difficulties of conducting such studies and discussing methodological and non-methodological issues [Goldenhar and Schulte, 1994, 1996; Zwerling et al., 1997].

METHODS

Recruitment of Participants

Contractors were recruited from the population of licensed residential and commercial painting contractors in San Francisco. We selected San Francisco as the project site because a large proportion (68%) of the housing stock was built before 1950, increasing the likelihood that employee participants would have significant exposure [Bureau of the Census, 1992]. Eligible companies had to: have two or more employees engaged in surface preparation work; have done no more than 80% of their work in the previous 12 months on buildings constructed after 1978; be substantially out of compliance with the OSHA construction lead standard (i.e., no air monitoring done in the previous 12 months and blood lead testing not done more than once); and be covered by workers' compensation insurance.

A brief eligibility questionnaire was mailed to 148 companies in Standard Industrial Classification 1721 (painting and paper hanging) identified through a listing from the California Employment Development Department (these are companies that pay into the state's unemployment insurance system). Twenty-one questionnaires were undeliverable, leaving 127 ''located'' companies. After up to two mailings and one phone contact, 22 (17%) did not respond and 4 (3%) refused to complete the questionnaire (response rate: 80%). Of the 101 respondents, 37 companies were considered ineligible, 4 were not painting contractors, 9 were not located in San Francisco, 2 were no longer in business, 15 had fewer than two surface preparation employees, and 7 worked primarily on newer buildings. No companies were excluded because they lacked workers' compensation insurance or were substantially in compliance with the OSHA lead standard. The remaining 64 companies were judged eligible to participate in the project.

Outreach was done prior to recruitment to publicize the project at local trade association (Painting and Decorating Contractors of America) and union (International Union of Painters and Allied Trades) meetings. Staff presentations emphasized the benefits participants would receive, including the potential for future business opportunities as the demand for lead-safe painting work grows.

The 64 eligible contractors were sent information about the project and encouraged to attend an informational meeting. Extensive telephone followup and provision of informational materials by fax and mail were needed to complete recruitment. Twenty-two companies (34%) agreed to enroll in the project and send their surface preparation employees to an informational session. Project staff met with employees, gave an overview of the project, and answered questions (employers did not attend this meeting). Each employee met one-on-one with project staff to review the consent form; 132 agreed to enroll and provided informed consent (only one employee declined to participate). Employer participants signed consent forms as well. The California Health and Human Services Agency Committee for the Protection of Human Subjects approved the project protocol, procedures for obtaining informed consent, and data collection instruments.

Intervention Methods

Project intervention activities took place from June through November, 1994. We chose this time frame to coincide with the highest seasonal activity period for painters.

Contractors attended four educational seminars (three Saturdays at 8-week intervals, one weekday evening) that covered why a comprehensive lead safety program is necessary and how to implement one in a stepwise fashion. The content included testing for lead in paint and air, safer surface preparation methods, respirators and protective clothing, housekeeping and hygiene, containment and environmental compliance, medical surveillance, and employee training. We used training methods known to be most effective with adult audiences such as: minimizing lectures and accompanying them with graphics and visuals; allowing ample time for questions, answers, and discussion; and including hands-on, participatory exercises and demonstrations. Hands-on demonstration of new equipment and work practices (e.g., HEPA-exhausted power tools, HEPA vacuums, plastic sheeting for containment) was emphasized. Another crucial aspect of the trainings was the use of a painting contractor with experience in lead safety practices as a "peer educator."

Material presented in each seminar was reinforced by distributing relevant chapters of a manual entitled "Painting Contractor's Guide to Lead Safety," which was developed for project participants. Nine chapters cover establishing a lead safety program, including resources to aid the contractor in implementing the practices covered.

Other assistance provided to contractors included: guidance in establishing a lead medical surveillance program and in locating providers of these services; free worker blood lead and ZPP testing at baseline and post-intervention; and an offer of 1 day of free industrial hygiene consultation with monitoring of employee airborne lead exposure and instruction in bulk paint sampling for lead content.

Participating employees were offered an 8-hr lead safety training in English, Spanish, or Chinese (Cantonese) that was designed to meet the current OSHA training requirement for lead-exposed construction workers. The content included the health effects of lead, identifying lead hazards at the job site, the lead medical program, controlling exposure, and the OSHA construction lead standard. Classes were held on work time with a class size of 20 or less. Interactive, participatory training methods were used, including hands-on demonstration of the use of respirators, protective clothing, HEPA vacuums, and HEPA-exhausted power tools. A set of 20 written fact sheets (in English, Spanish, or Chinese) was provided to each participant to reinforce information covered in the trainings. Participating employees received written notification and explanation of blood lead and ZPP levels for testing provided by the project. Those with children also received a separate letter addressing how to prevent take-home lead exposure and recommending that household members get blood lead tests.

In addition, project staff (industrial hygienists, health educators, nurse practitioner) were available throughout the project to provide consultation and technical assistance by telephone to either employer or worker participants.

The educational aspect of the intervention strategy drew on the theories of empowerment education [Friere, 1983], the diffusion and adoption of innovations [Rothman, 1974], and the health belief model [Rosenstock, 1974]. Empowerment education seeks to give students the ability to identify and solve problems collectively, using their own experience. The diffusion and adoption approach is a process by which new ideas or practices are propagated and gain acceptance by groups of people. The health belief model maintains that individuals take action to avoid disease when motivated by certain factors.

Several key principles guided the design of the intervention strategy. First, multiple factors which affect health and safety should be addressed simultaneously to maximize impact. Second, both employers and workers should be participants in the intervention in order to bring about significant change at the work site. Third, the intervention should either directly provide or facilitate access to the tools and resources necessary for making improvements. Finally, the small business owner is most likely to adopt improved health and safety practices when introduced to the material in a stepwise manner and when clear guidance is given concerning the relative importance of specific changes.

Evaluation and Data Collection Methods

The project evaluation was based on a combination of evaluation theories and models including: determining program effectiveness by comparing actual program

performance with a standard of expected performance [Wholey, 1986]; gathering qualitative data to assess how and why a program works or does not work [Patton, 1980]; assessing a program's conceptualization and implementation as well as its impact [Rossi and Freeman, 1985]; and tailoring evaluation to answer questions critical to the particular stage of a program's development [Rossi and Freeman, 1985]. A variety of methods were used for process and formative evaulation.

For evaluating the impact of the project, a design was chosen in which participants served as their own control group and changes were measured by making repeated observations over time [Posavac and Carey, 1992]. The same quantitative interview data were collected at baseline (June 1994), immediately post-intervention (November, 1994), and 1 year later (Summer, 1995). In addition, some questions were asked only at 1-year follow-up (for these questions we asked participants to recall how often they were doing the specific practice at baseline). Qualitative post-intervention data were collected in March, 1995 through focus groups with participating employers.

We established measurable impact objectives, i.e., performance standards or levels of expected change, against which to judge the success of the intervention. Twenty-seven objectives pertain to desired changes in employer behavior/work practices (Table I) and 12 to worker behavior/work practices (Table II). Each objective is defined with respect to the target population, i.e., the particular subset of participants who, based on responses to the baseline questionnaire, could show improvement in the specific area. A positive percent change reflects the proportion of the target population that either: (1) decreased use of an unsafe practice; or (2) increased use of a protective measure.

For example, we encouraged employers to control employee exposure by substituting wet sanding for dry manual sanding and set an objective that 50% of target employers would decrease their use of dry sanding. At baseline, 21 employers reported dry sanding often (19) or sometimes (2); all could improve in this area by decreasing their frequency of dry sanding; thus, all were in the target population for this objective. [By Summer, 1995 one company reported no longer doing dry sanding and four companies changed from dry sanding often to only sometimes; thus, 5 out of 21 companies improved (+25%). This did not meet the objective of a 50% improvement.].

Lacking similar studies of this population in the literature by which to guide the process of setting performance standards, our targets for expected improvement were subjective. We developed impact objectives after baseline data collection and intervention activities, but prior to data analysis. Factors we considered in setting expected levels of change were: performance levels found at baseline (i.e., how bad practices were initially), changes considered most important in reducing worker lead exposure, content areas emphasized during the intervention, and staff perceptions regarding the technological and economic feasibility of making specific changes. For example, since making a change in an area such as employer provision of protective clothing did not cost a lot of money, was very important to preventing take-home lead and required by the OSHA standard, and was repeatedly emphasized in the trainings, we set that objective for change at a high level of 75%.

Standardized questionnaires were administered by trained interviewers at baseline and two points post-intervention to collect information about the characteristics and practices of participating employers and employees. Questionnaires had been pre-tested with painters and contractors who were not project participants. Employer interviews lasted approximately 30 min, and worker interviews 30–45 min. Participants had the option of being interviewed in English, Spanish, or Cantonese. Employers who did surface preparation themselves completed both employer and worker interviews. In June, 1994 and November, 1994, all interviews were done in person. Interviews at 1-year follow-up (Summer, 1995) were done either in person or by telephone.

The purpose of post-intervention employer focus groups was to collect qualitative data on the impact of the intervention activities on participants' lead safety programs, work practices, and business practices. They were intended to provide insight into employers' successes and failures in reaching objectives and to elicit employers' recommendations for future interventions. Questions were developed with the assistance of two consultant evaluators who conducted and audiotaped the two simultaneous sessions with employers.

In addition, follow-up site visits were conducted during Summer–Fall, 1995 at three job sites during surface preparation on lead-containing paint. Site visits were arranged in advance with each employer. The decision to limit to three site visits was based on resource availability and scheduling difficulty. The purpose was to observe directly the use of lead safety practices on these sites, providing an assessment of the validity of contractors' reporting on the 1-year follow-up questionnaire (Summer, 1995). At each site visit, observations were made in each of 14 areas and then compared with employers' answers to questions that addressed the same areas in the 1-year follow-up employer interviews. Each comparison was categorized as: observation inadequate to allow a comparison with questionnaire; observation in general agreement with questionnaire reporting; or observation in disagreement with questionnaire reporting.

Data Analysis

Changes over time in 27 employer and 12 worker lead safety practices were analyzed and compared to performance objectives. For each variable measured at baseline,

TABLE I. Employer Changes in Lead Safety Practices: Size of Target Population, Objectives, and Percent Change at Post-Intervention and One-Year Follow-up

Practice targeted for change	# In target population	Objective: % change[a]	% Change: post-intervention[a]	% Change: 1-year follow-up[a]	Objective met at 1-year follow-up?
Identification of lead paint					
Using color-indicating tests	18	+75	+83	+75	Yes
Surface preparation methods					
Dry manual sanding	21	−50	−29	−25	No
Dry manual scraping	21	−33	−19	−19	No
Using HEPA-exhausted power tools	21	+50	+14	+33	No
Open flame burning	12	−50	−42	−67	Yes
Respiratory protection					
Selecting appropriate respirator for manual sanding	15	+90	+80	+87	Almost[b]
Selecting appropriate respirator for power tools without HEPA exhaust	18	+50	+11	0	No
Providing updated medical clearance for respirator users	17	50[c]	N/A	18	No
Providing medical clearance for new hires	5	50[c]	N/A	50	Yes
Providing fit testing in past 6 months	17	+50	+47	+47	Almost[b]
Protective clothing and hygiene					
Providing protective clothing	14	+75	+43	+65	No
Taking steps to ensure work shoes not worn home	18	+75	N/A	+75	Yes
Ensuring washing equipment is available	13	+90	+54	+60	No
Prohibiting eating, drinking, use of tobacco products in work area	17	+90	+76	+60	No
Housekeeping, containment, and environmental control					
Using dry sweeping	21	−75	N/A	−67	No
Misting before sweeping	19	+90	N/A	+84	No
Cleaning with HEPA vacuum	21	+50	+33	+62	Yes
Using tarps on interior floors	20	−50	−35	−55	Yes
Using plastic sheeting on interior floors	13	+50	+62	+46	Almost[b]
Using containment on scaffolding	17	+30	+47	+47	Yes
Sealing rooms during interior surface preparation	17	+50	N/A	+47	Almost[b]

TABLE I. (*Continued*)

Practice targeted for change	# In target population	Objective: % change[a]	% Change: post-intervention[a]	% Change: 1-year follow-up[a]	Objective met at 1-year follow-up?
Sealing windows and doors during exterior surface preparation	20	+75	N/A	+85	Yes
Using tarp or plastic during exterior surface preparation	17	+50	N/A	+76	Yes
Protecting drains and sewers from chips	17	+50	N/A	+100	Yes
Taking steps to ensure proper waste disposal	20	+50	N/A	+70	Yes
Medical program					
Providing routine BLL and ZPP testing	21	+90	N/A	+57	No
Employee training					
Providing lead safety training to new hires	10	50[c]	N/A	40	No

[a]Change in target population (those who could improve) as compared to baseline.
[b]Almost = change was within 5% of objective.
[c]Objective set as a target rather than change from baseline level.
N/A = not available; data not evaluated post-intervention.

the ''target population,'' or group that could make a desired improvement, was determined (e.g., those who could increase frequency of a safe practice from ''never'' to ''sometimes'' or ''always''). Then, the proportion of the target population that had improved by post-intervention (November, 1994) and 1-year follow-up (Summer, 1995) was calculated and compared to the set objective. Because this study featured a single group design of non-randomly selected employers and their employees, we chose to report evaluation results in a descriptive manner rather than employ formal statistical analysis methods.

Focus group data were analyzed by the evaluation consultants who applied a coding scheme to the transcripts of audio tapes to elicit common themes and categories of responses. They provided the project with a summary report which included salient quotes from participants without personal identifiers.

RESULTS

Description of Participants

Employers

Twenty-one employers participated in the entire project (one company dropped out early in the project after going out of business). Company size ranged from 1 to 54 employees, with an average of 10 and median of 4.5. The average number of years that a company had been in business was 17.6, with a range of 2–72 years.

The majority of companies (62%) primarily did residential work; 19% commercial work; and 19% did an equal mix of both. During the year preceding February 1994, employers reported spending an average of 50% of their time working on structures built before 1950, 28% on structures built between 1950 and 1978, and 21% on structures built after 1978. Only 29% of companies were involved in painting metal structures.

Only 15% of companies were unionized. Less than half (43%) were members of the primary trade association for residential painting contractors, the Painting and Decorating Contractors of America.

Eighty-one percent of employers said English was their first language; one was interviewed in Cantonese. In response to questions about employers' need to provide employee training in languages other than English, over half said they had employees who would prefer training in Spanish (55%) or written materials in Spanish (65%).

The 21 participating companies were compared to the 43 eligible companies which did not participate. Both groups were similar in average number of employees, proportion of residential versus commercial work, percentage of work on pre-1950 or 1950–1978 buildings, frequency of doing power sanding and torch burning, frequency of conducting personal air monitoring, trade association membership, and unionization.

TABLE II. Employee Changes in Lead Safety: Size of Target Population, Objectives, and Percent Change at Post-Intervention and One-Year Follow-Up

Practice targeted for change	# In target population	Objective: % change[a]	% Change: post-intervention[a]	% Change: 1-year follow-up[a]	Objective met at 1-year follow-up?
Respiratory protection					
Performing daily face seal check	75	75[b]	N/A	65	No
Preventing ingestion and take-home					
Wearing work clothes home	63	−75	−59	−62	No
Wearing work shoes home	69	−75	−38	−48	No
Washing before eating	24	+75	+58	+79	Yes
Washing before drinking	48	+50	+44	+50	Yes
Washing before smoking	14	+50	+50	+64	Yes
Washing before going home	22	+90	+82	+82	No
Eating in work area	71	−90	−49	−62	No
Drinking In work area	77	−75	−47	−49	No
Smoking In work area	18	−75	−17	−56	No
Housekeeping					
Using dry sweeping	85	−75	N/A	−44	No
Misting before sweeping	81	+90	N/A	+53	No

[a]Change in target population (those who could improve) as compared to baseline.
[b]At baseline few employees wore respirators; objective set as a target rather than change from baseline level.
N/A = not available; data collected only at 1-year follow-up.

Employees

A total of 132 painters from 21 companies participated in baseline data collection. This group (referred to as ''employees'' or ''workers'') primarily consists of employees but also includes 12 company owners who conduct surface preparation work themselves. Workers were all male with an average age of 35 years (range 20–57 years). Fifty-four percent were non-Hispanic white, 27% Hispanic, 15% Asian, and 4% African-American. Forty-three percent of the workers were born in the US. Most workers (73%) were interviewed in English, with 18% interviewed in Spanish and 9% in Cantonese. Three-quarters of the participants were high school graduates, slightly over half of whom had at least some college-level education. On average, the participants had been painters for 11 years (range: 6 months to 41 years), and most (83%) were not union members. Thirty percent had been employed by the current company for less than 1 year, 40% for 1 to 5 years, 14% for 6–10 years, and 16% for 11 or more years. The majority of the workers did not smoke (64%) or use other tobacco products (96%).

For the analysis of changes in work practices over time, data are available at three points in time (baseline, post-intervention, and 1-year follow-up) on 89 of the original group. The reasons why 43 workers were lost to follow-up were not systematically investigated but included changes in employment or inability to contact by telephone for the final interview.

No significant differences were found between the workers who completed the project and those lost to follow-up, except in the area of smoking. Only 28% of the workers included in the analysis were smokers, whereas 72% of those excluded were smokers (Chi-square, $P<0.05$).

Changes in Employers' Lead Safety Practices

The overall results with respect to all 27 project objectives for changes in employer lead safety practices appear in Table I. The number of employers in the target population, i.e., those who could improve their frequency of

a lead-safe practice or decrease their frequency of an unsafe practice, is also shown in Table I. By comparing this number to the total of 21 contractors, the reader can get a sense of how widely these specific practices were being used (or not used) in a population of contractors who are motivated enough to participate in a voluntary project.

At baseline, participating employers generally were not using safer work practices or providing adequate protections for employees. For example, only 14% of contractors often used color-indicating tests for lead in paint, and 48% never did (laboratory analysis of paint chips was rarely done). Dry manual sanding and uncontrolled power sanding were common, and 95% of contractors did not use HEPA-exhausted power tools. Only 29% of employers provided half-mask respirators with HEPA filters (now known as N- or P-100) for employees hand sanding on lead paint. Sixty-seven percent did not provide adequate protective clothing covering employees' arms and legs. Misting debris before sweeping, to minimize dust generation, was not frequently done. Most contractors never sealed windows and doors with plastic sheeting during exterior surface preparation to prevent contamination of living spaces. None of the employers routinely provided BLL and ZPP testing for employees. Further detail on the prevalence of lead-safe practices may be found in a technical report available from CDHS [CDHS, 1998].

At 1-year follow-up, target employers (i.e., those in the target population for each objective) had met or almost met (within 5%) established objectives in 15 of 27 areas, and made a 50% or greater improvement (57–84%) in 6 of the 12 areas where the objective was not met (Table I).

Where data are available at three points in time, we can see that lead safety changes in several areas were made immediately post-intervention and sustained through 1 year later (e.g., use of color-indicating tests for lead in paint, respirator selection for dry manual sanding). Some changes took longer for larger numbers of employers to adopt (e.g., use of HEPA-exhausted power tools, provision of protective clothing).

Changes in Employees' Lead Safety Practices

At baseline, lead-safe work practices were not common among participating employees. For example, 52% of employees who wore respirators were not doing daily face seal checks. Wearing work clothes and shoes home and eating in the work area were common practices, and approximately one-third of the workers reported that they did not always wash up before eating.

Table II summarizes improvements in employee practices among the target population for each of the 12 objectives set. At 1-year follow-up, employees met the target objectives in three of the 12 areas: washing before eating, drinking, and smoking. Of the nine areas where objectives were not met, employees made 50% or greater improvement (53–82%) in six of them. An improvement of 44–49% was noted in the three remaining areas.

Contractor Focus Group Findings

From the focus group discussions, a number of themes were identified.

Contractors reported that the factors which motivated them to initially join and stay involved in the project were: a desire to become educated about lead safety; a desire to decrease their liability by being in compliance with the OSHA lead standard; the free or low cost services provided such as employee training in multiple languages, blood testing, and air monitoring; an interest in the research-based approach and the opportunity to potentially influence policy; the perception that the project staff conducted themselves in a professional, open-minded manner; and the opportunity to interact with peers.

The aspects of the project that contractors identified as helping them to make improvements in lead safety included: the training seminars, particularly being introduced to the material over time, hands-on demonstrations, and networking with and learning from other contractors; blood lead testing as a means of providing feedback regarding lead exposure; and air monitoring.

Contractors identified a number of obstacles that make it difficult for them to improve lead safety. The additional cost of including lead-safe procedures and justifying the expense to customers was of great concern. The costs of specific items such as blood testing, insurance, and hazardous waste disposal were mentioned as barriers. Some contractors expressed frustration with the expense of equipment (e.g., HEPA-exhausted sanders, HEPA vacuums), its availability, or with the difficulty in obtaining adequate information on which to base purchases. Some contractors remained concerned about meeting all aspects of occupational and environmental regulations, including record keeping, and felt that employees would need constant reminders in order to maintain safety practices.

Contractors reported that participating in the project had affected their approach to conducting their business. For example, some contractors now sought work identified as "lead abatement," and were being selected because of their experience. Some had started to advertise their knowledge about lead paint hazards. Contractors stated they were more comfortable communicating with customers about lead safety. However, they cited a general lack of public awareness of lead paint hazards and customer unwillingness to pay the additional costs of lead safety as ongoing problems. Contractors also reported changes in their relationships with

employees; their employees were more likely to identify potential lead paint, consistently take safety precautions, and request the necessary equipment and supplies to complete a job safely.

Overall, the project was perceived by contractors to be effective in helping them and their employees create a safer work environment. Throughout the discussions contractors conveyed a positive and appreciative tone toward the project and its staff. Recommendations provided by contractors for improving the project included more use of peer educators and hands-on instruction, reducing the size of the manual and making it more user friendly, consolidating regulatory information into one document, and creating visuals such as videos, posters, and CD ROM software as instructional aides.

Follow-Up Site Visits

Three visits were conducted in Summer–Fall, 1995 to job sites during surface preparation activities, and observations were made in 14 areas (total n=42). Of the 42 observations, 14 (33%) were inadequate to allow a comparison with employer questionnaire reporting, 26 (62%) were in general agreement with questionnaire reporting, and 2 (5%) were in disagreement with questionnaire reporting.

DISCUSSION

Changes in Lead Safety Practices

Contractors and their employees showed improvement in many areas, indicating that motivated contractors who are substantially out of compliance with the OSHA construction lead standard can successfully be encouraged to implement components of a lead safety program. In general, participants were most successful at making changes that were simple and straightforward, a familiar part of the day-to-day operations, inexpensive or considered reasonably priced. Accordingly, there were large improvements in the use of colorimetric testing for lead in paint, half-mask respirators with HEPA filters, containment, and safe clean-up methods. Contractors were familiar with the use of respirators to protect workers and were responsive to the recommendations to upgrade to HEPA respirator filters and provide fit testing and initial medical clearance. Improvements in housekeeping and containment practices may have resulted because contractors realized that these changes could reduce clean-up time and therefore lower labor costs, decrease contractor liability for contamination of the customer's property, and improve customer satisfaction.

The project had less success in getting contractors to change surface preparation methods. This area was expected to be difficult to affect because it is so crucial to the quality of a paint job and customer satisfaction. The use of open flame burning decreased, however contractors cited a general industry-wide decrease in this method due to fire risk. Thirty-three percent of target employers (those who could improve in this area) increased use of HEPA-exhausted power tools despite their significant cost. Others felt the cost was prohibitive, the technology was still not sufficiently developed, or that they still lacked enough information on these tools. Although contractors understood the hazards of lead dust from dry sanding, only 25% of target employers decreased their use of this method. Many contractors considered the alternative of wet methods to be unfeasible and problematic, with moisture being perceived as a threat to the quality of the work.

Employees made important changes to prevent ingestion of lead and taking lead home to their families, though they sometimes did not reach target objectives that were set fairly high. For example, 82% of target employees increased frequency of washing before going home, indicating that they grasped the message about take-home exposure and acted on it. Some workers who continued to wear home work clothes or shoes stated in the interviews that they now changed before entering the home. From 49–62% of target employees decreased eating, drinking, or smoking in the work area, despite the fact that 40% of target employers reported they did not implement a clear policy prohibiting these activities.

The target objective was not met for continued provision of medical surveillance. Although contractors remarked in focus groups that they liked the feedback that blood testing provided on implementation of lead safety measures, only 57% sent any workers for testing in the summer of 1995 despite repeated reminders by their selected medical provider. Cost was mentioned as an obstacle to ongoing blood testing. In addition, some employers stated that the disruption of work and difficulty of scheduling employee clinic visits during work hours prevented them from conducting routine blood testing.

Although employers were provided with training materials they could use with new employees, less than half the target employers provided 4 hr or more of lead safety training to new hires. Expecting 4 hr of training may have been unrealistic; they may have lacked the confidence to deliver training (seminars did not include development of employers' training skills) or felt the cost of outside training was prohibitive. During the focus groups, contractors mentioned a reluctance to invest in outside training since employees may not remain with the company. Since contractors believed that the outside training provided by the project was very effective, it is possible that more would utilize training services if they were more affordable and more accessible.

Data collected 1 year after the intervention show that contractors and employees were able to maintain improved work practices, and in some cases make additional

improvement. As could be expected, employers took a longer time to implement sizable financial investments such as the purchase of HEPA vacuums and HEPA-exhausted power tools.

Project Limitations

Quantitative evaluation data collected in this project were primarily self-reported by employers and workers, raising a question as to its reliability. We found, however, that both groups were candid about their failure to implement many straightforward lead safety practices promoted in the training. This suggests that participants were being truthful and accurate overall in their responses since there is no reason to believe they would exaggerate their progress in one area more than another. Secondly, in a number of areas, we had a second, independent source of information (i.e., a contractor's employees' responses to the same questions, reports from the medical clinic on medical issues, or follow-up visits to three job sites). Where comparisons were possible we found few areas of disagreement. Thus, we believe that measured changes are likely to be accurate.

We must then consider whether the observed changes were attributable to the intervention activities or to other factors. We are aware of two possible factors at the time of the intervention that may have influenced participants: California's new OSHA construction lead standard, which became effective in October 1993; and media attention to lead hazards. However, we do not believe either factor significantly accounted for contractors' and workers' decisions to adopt lead-safe practices. At the start of the project most contractors were unaware of the contents of the OSHA standard and, during the time of the project, OSHA had no targeted enforcement action underway. Local health department childhood lead programs were doing outreach to the general public about the hazards of lead paint to children. This publicity may have raised awareness among contractors and employees, but it did not provide the detailed information, resources, and tools necessary for making the observed changes in business and work practices.

The primary drawback of our voluntary approach was that the participants are not necessarily representative of the larger universe of painting contractors. The participating contractors are likely to be similar to licensed painting contractors in other locales in that they have few resources for health and safety and do not have dedicated health and safety staff. They are likely to represent the more motivated employers, as continued participation throughout the project required a considerable investment of company time and resources. Therefore, we believe our findings can be generalized to other motivated contractors, those likely to participate in a voluntary program and also the type of contractor who in general would implement a lead safety program. Despite aggressive recruitment efforts, we succeeded in persuading only 21 of the 64 eligible contractors to participate. Anyone considering replicating this approach should consider that large numbers of residences in San Francisco contain lead paint and at the time of the project lead paint hazards in housing were the focus of substantial public attention; recruitment efforts in areas of the country without these factors might be more difficult. We do not expect that this approach would work with unlicensed contractors, who would be unlikely to participate in a project conducted by a government agency.

A quasi-experimental research design (i.e., utilizing control and treatment groups) would have provided increased assurance that our results were due to the intervention and could be generalized to other painting contractors and employees by allowing a broader range of statistical techniques by which to analyze data on impact/outcome. As this study was viewed as only an evaluation of possible intervention effects and not a true experimental test of the effectiveness of the intervention, we analyzed and reported our results in a descriptive manner. We relied on comparison to specific performance objectives that were set based on little advance knowledge about what is reasonably achievable in a comprehensive workplace intervention project. In retrospect, we believe that we set unreasonably high target objectives in many cases (e.g., expecting that 90% of the target population would change a specific work practice). Given that we were attempting to influence a very complex phenomenon, a major change in the "culture" and practices of an industry, our expectations for improvement should have been more modest.

CONCLUSIONS

Although participating contractors and workers fell short of achieving many of the objectives set, we believe that the moderate improvements made show that the project's intervention strategy of education, training, and technical assistance, implemented in a stepwise manner, was effective in inducing motivated residential/commercial painting contractors to establish lead safety programs and encouraging workers to use safe work practices. Further, these improvements were sustained over time.

Our inability to meet employer objectives in the areas of safer surface preparation methods, medical surveillance, and employee training indicates the need for some changes in the intervention approach (e.g., more hands-on training for new work practices), more feasible alternatives to unsafe surface preparation methods, and less costly, more accessible services and products. Approaching employers with a cooperative attitude, an open mind, and clearly communicating a willingness to listen and learn from them were critical to the project's success.

Due to resources required, full implementation of the project's comprehensive intervention strategy may not be feasible for state or local health departments or others.

However, aspects of the model can be adapted to the needs and resources of local programs.

Learning to work with small businesses and their employees to change the workplace culture (i.e., multiple aspects of how work is done) is both challenging and an important area of intervention research to effect occupational safety and health improvements. Having the resources and ability to recruit an adequate number of eligible participants will greatly influence evaluation design. Qualitative evaluation methods provide rich data which are less dependent on evaluation design issues. Intervention effectiveness researchers should plan to devote significant resources to both recruitment and evaluation.

Given the challenges and resource-intensiveness of intervention research projects we feel it is important to design such projects as pilots where some dimension of the research findings can later be disseminated or applied to a larger audience. After learning a great deal about the painting industry through this project, we conducted a follow-up program which presented 34 half-day lead safety awareness seminars reaching 1100 painting and remodeling contractors across California.

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